

Adopted at Fourth Annual  
Meeting of Amer. Sect. June 29, 1901.  
Subject to letter ballot.

INTERNATIONAL  
ASSOCIATION FOR TESTING MATERIALS.  

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AMERICAN SECTION.

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BULLETIN No. 13.

MAY, 1900.

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PROPOSED STANDARD SPECIFICATIONS  
FOR  
STEEL AXLES.

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RECOMMENDED BY AMERICAN BRANCH OF COMMITTEE NO. 1, MAY 1, 1900.

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There will be a discussion of these specifications at the Third Annual Meeting of the American Section, to be held in New York, on October 25-27, 1900, and you are requested to send in your views by letter, or to be present and take part in the oral discussion.

After the Annual Meeting, Committee No. 1 will consider the points raised, and make any modifications that may be found necessary; and, if so decided at the Annual Meeting, the specifications will be sent to all members of the American Section for approval by letter ballot.

If the other countries perform their work in the same general manner, the final work of the introduction of International Specifications will be reduced to a very simple matter, as there will only be a limited number of specifications to consider instead of hundreds as at the present time.

WM. R. WEBSTER,  
*Chairman of American Branch of Committee No. 1.*

## PROCESS OF MANUFACTURE.

1. Steel for axles shall be made by the open-hearth process.

## CHEMICAL PROPERTIES.

2. There will be three classes of steel axles which shall conform to the following limits in chemical composition.

	Car, engine truck and tender truck axles. Per cent.	Driving wheel axles. (Carbon steel.) Per cent.	Driving wheel axles. (Nickel steel.) Per cent.
Phosphorus shall not exceed.....	0.06	0.06	0.04
Sulphur " " " ".....	0.06	0.06	0.04
Nickel " " " ".....	.....	.....	3-75

## PHYSICAL PROPERTIES.

3. For car, engine truck, and tender truck axles no tensile test shall be required.

4. The minimum physical qualities required in the two classes of driving wheel axles shall be as follows:

	Driving wheel axles. (Carbon steel.)	Driving wheel axles. (Nickel steel.)
Tensile strength, pounds per square inch.	80,000	80,000
Yield point, pounds per square inch.....	40,000	50,000
Elongation, per cent. in two inches.....	18	25
Contraction of area per cent.....	..	45

5. One axle selected from each melt, when tested by the drop test described in paragraph No. 9, shall stand the number of blows at the height specified in the following table without rupture and without exceeding, as the result of the first blow, the deflection given. Any melt failing to meet these requirements will be rejected.

Diameter of axle at center. Inches.	Number of blows.	Height of drop. Feet.	Deflection. Inches.
4 1/4	5	24	8 1/4
4 3/8	5	26	8 1/4
4 7/16	5	28 1/2	8 1/4
4 5/8	5	31	8
4 3/4	5	34	8
5 3/8	5	43	7
5 7/8	7	43	5 1/2



Name.	Number and date.	Kind of axle.	Material.	Designation of axle.	Weight.			Chemical Composition, D, denotes desired; B, below; A, above.													
					Normal.	Max.	Min.	Carbon.			Manganese.			Silicon.			Phosphorus.				
								D	B	A	D	B	A	D	B	A	D	B	A	D	
Pennsylvania Railroad Co.	16-D Sept. 22, 1899.	Car and tender truck. Engine truck.	Open hearth.	P. R. R. 2B " 4A M. C. B. 4 B Pullman 5F M. C. B. 6A P. R. R. 7 " 11 " 12 " 13 " 14				.40	.35	.50	.50		.60	.05			.05		.07	.04	
Master Car Builders' Association	1899.	Car axles	Open hearth.	4 1/8 x 8 5 " x 9 5 1/2 x 10				.40	.35	.50	.50		.60	.05			.05		.07	.04	
Baltimore & Ohio R. R.	2-B Mar. 1, 1898.	Pass. and frt car. Tender and truck.	Open hearth					.20					.70						.06		
Chicago & Northwestern Ry.	Apr. 1, 1898.	Car axles	Open hearth.																		
Chicago, Burlington & Quincy	27 July 1, 1899	Pass. and frt car and tender truck.	Axles must be annealed or allowed to cool slowly under conditions satisfactory to inspector. Etching of end or section of axle to show homogeneous material					.35	.50				.60						.05		
Chicago & Alton R. R.	Dec. 21, 1899.	Freight car.	Open hearth (25% discard from tops of ingots)	4 1/4 x 8 5 x 9				.40	.35	.50	.50		.60	.05			.05		.07	.04	
Canadian Pacific Ry.	Dec. 1898.	Freight	Steel tough and uniform.	Print 787				.40	.35	.50	.50		.60	.05			.05		.07	.04	
	Jan. 5, 1899.	Pass	Steel tough and uniform	4 1/4 x 8				.35	.30	.40	.50		.60	.05			.05		.05	.04	
	Feb. 15, 1899.	Pass.	25% discard from tops of ingots	5 x 9				.35	.30	.40	.50		.60	.05			.05		.05	.04	
	Apr. 6, 1897.	Loco. truck Tender.																			
Erie Railroad Co.	M-P 70 B Feb. 1, 1897	Freight.	Open hearth. Not less than 25% in weight to be discarded from tops of ingots.	4,180 3,035 1,658 661 3,035 661 4,180 3,849 5,570 5,571	490 495 450 445 405 445 490 465 480 450	Variation from specified weight's must not exceed 10 lbs.															
	M-P 28 C Feb. 1, 1897	Pass.																			
		Freight and Pass.		1 Frt. 1 Pass. 2 Frt. 3 Pass.	495 495 395 450																
				5 Frt. 6 " 7 " 8 " 9 " 10 " 11 "	525 485 370 420 560 675 813		5 0 470 355 405 540 655 788														
Lake Shore & Michigan Southern Ry.	March 1, 1899.	Tender and truck.	Open hearth. Not less than 25% in weight to be discarded from tops of ingots.										.60						.04		
Lehigh Valley R. R.	6 F May 13, 1899.	Car and tender.	Open hearth. 25% discard from tops of ingots.	Sl. - 415	382	390	374														
				Sl. - 441	490	500	480	.40	.35	.50	.50		.60	.05			.05		.07	.04	
				Sl. - 8.9	665	667	653														
				Sl. - 2,252	791	807	775														
Northern Pacific R. R.	25 Dec. 15, 1898.	Car and loco. Tender and truck.	Open hearth. To be annealed in annealing furnace after forging.																		
Philadelphia & Reading R. R.	April 15, 1898.																				
C., C., C. & St. L. R. R.	22 July, 1897.	Car and tender truck.	25% discard from tops of ingots.					.35			.50								.04		
Not over 5% variation will be allowed from this analysis.																					
Norfolk & Western Ry.	11-D Oct. 12, 1897.	Freight and Pass.	Open hearth.																		
Pittsburg & Lake Erie R. R. Chicago, St. Louis, Minneapolis & Omaha Ry.	Same as Erie Same as Chicago & Northwestern Ry.	Railroad specifications No. 70-B.																			
Southern Railway	May 12, 1899.	Car, loco. and tender truck.	Open hearth										.70						.07		
Carnegie Standard								.23	.28										.04		
Plant System	1898.	Car.																			
Chicago & Eastern Illinois R. R.	12 Feb. 6, 1897.		Open hearth.					.40	.35	.50	.50		.60	.05			.05		.07	.04	

SYNOPSIS OF SPECIFICATIONS FOR RAILROAD AXLES.

COMPILED FOR COMMITTEE NO. 1, AMERICAN SECTION OF THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

Sulphur.				Physical properties.						Test piece.	Drop test.								Remarks.
				Ultimate strength per sq. inch.			Elastic limit.	Elongation, per cent.			Bending.	Diameter at center, inches.	Weight of drop, pounds.	Height of drop, feet.	Distance between supports, feet.	Number of blows.	Desired deflection, inches.	Maximum deflection, inches.	
				Desired.	Not less than.	Not more than.		Desired.	Not less than.										
A	D	B	A																
.07	.04			None required.						Test piece 6 in. long cut from test axle. Borings for analysis will be taken by 5/16 in. drill acting parallel to axis of axle at a point on radial line, 40% of distance from center to circumference.	4 7/8	1,610	28 1/2	3	5	7 1/4	8 3/4	Drop machine to have spring base as described in specifications. Axles must be turned over after first and third, and when required after fifth blow.	
									4 3/4		1,610	31	3	5	5	7	8		
									4 3/4		1,610	34	3	5	5	7	8		
									4 3/4		1,610	34	3	5	5	7	8		
									5 5/8		1,610	43	3	5	5	7	8		
									4 3/4	1,610	25 1/2	3	5	5	5	5 1/2	6 1/2		
									5	1,610	38 1/2	3	5	5	5	5 1/2	5 1/2		
									5 1/4	1,610	43	3	5	5	4 3/4	5 1/2	4 3/4		
									5 1/2	1,610	43	3	5	7	4	4 3/4	4 3/4		
.07	.04									Ditto.	4 5/8	1,610	31	3	5	7	8	Ditto.	
									5 5/8		1,610	43	3	5	7	4 3/4	5 1/2		
									5 5/8		1,610	43	3	5	7	4 3/4	5 1/2		
.06			.04								4 3/4	1,610	23	3	5			Firm supports. Axle to be turned over after each blow. For axles over 4 1/4 in. diameter, at center add 2 ft. to height of drop for each 1/4 in. increase at center.	
											4 3/4	1,610	23	3	5			Axle to be turned over after each blow. Increase height of drop 1 ft. for each 1/4 in. in diameter of axles over 4 1/4 in. at center.	
.05			.05							Borings to be taken from one end of axle half way between center and circumference.	4 1/4	1,610	26	3	5		7	Drop machine same as M. C. B.	
									4 5/8		1,610	32	3	5			7		
									5 5/8		1,610	43	3	5			7		
.07	.04									Test piece 6 in. long cut from test axle. Borings for analysis will be taken by 5/16 in. diameter drill acting parallel to axis of axle at a point on radial line 40% of distance from center to circumference.	4 5/8	1,610	34	3	5	7	8	Drop machine same as M. C. B.	
									5 5/8		1,610	43	3	5	6	7	7		
.07	.04											1,610	25	3	5			Turn axle over after each blow.	
.05	.04											1,610	27	3	6			Ditto.	
.05	.04									Drillings for analysis to be taken half way between center and edge with 5/16 in. diameter drill.		1,610	40	3	5	7	8		Ditto.
					75,000			15 in 2 in.					1,650	20	3	6			Axle to be turned after 1st, 3d and 5th blows.
													1,650	28	3	6			
														1,610	25	3	5		
												1,610	15	3	3		6 after first blow.	Rigid supports. Axle to be turned over after each blow. Axle to receive 8 blows.	
										Journals		1,610	25	3	5				
											4 1/4	1,610	28	3	5			Axle to be turned over after each blow.	
											4 1/4	1,610	28	3	5				
											3 3/4	1,610	20	3	5				
											3 3/4	1,610	25	3	5				
											4	1,610	28	3	5				
											4	1,610	25	3	5				
											4	1,610	18	3	5				
											4 1/4	1,610	20	3	5				
											4 1/4	1,610	28	3	6				
											5	1,610	40	3	6				
					54,000	64,000	32,000		22 in 8 in.		5 1/2	1,610	40	3	8				
.07	.04									For chemical analysis piece of axle will be cut at a distance of 14 in. from end, and a circle inscribed on face of section thus made, having for radius 40% of radius of section. Borings will be taken with 5/16 in. drill acting parallel to axis of axle and starting on 40% circle.	4 3/4	1,610	28 1/2	3	6	7	8	Drop machine same as M. C. B. Axle to be turned over after 1st, 3d and 5th blows. If test axle fails two more must stand test to accept heat.	
									4 5/8		1,610	31	3	6	7	8			
									5 5/8		1,610	43	3	5	6	7			
									5 5/8		1,610	43	3	7	4 3/4	5 1/2			
											4 1/4	1,610	25	3	5		8 after any blow.	Drop machine same as M. C. B. Axle to be turned after each blow.	
											Two feet additional to height of drop for each additional 1/4 in. diam. at center.								
				75,000	70,000			2 1/2 in 2 in.	15	Two test pieces cut from test axle, the centre lines of which shall be 1 in. from centre line of axle.	4	1,610	20	3	5			Axles to be turned over after 1st and 3d blows. For excess in diam. of axles add 2 ft. to height of drop for each 1/4 in. increase in diam. at centre. If drop machine is of spring base pattern add 2 ft. to heights given in table.	
											4 1/4	1,610	23	3	5				
											4 3/8	1,610	21	3	5				
											4 1/2	1,610	26	3	5				
											4 3/4	1,610	28	3	5				
											4 3/4	1,610	30	3	5				
.04			.05								4 1/2	1,610	25	3	10			Axles to be turned over after each blow.	
											4 3/8	1,610	28	3	10				
											4 5/8	1,610	29	3	5			Axle to be turned over after each blow.	
.07										Drillings for analysis to be taken from end of test axle 1/2 of distance outward from centre to circumference.	4 5/8	1,610	31	3	5		8 1/4	Test given is for spring base. If solid base 2 ft. will be allowed from height of drop.	
.01			.01									Add 2 ft. to height of drop for 1/4 in. each increase in diam. at centre.							
										Drop test same as B. & O. R. R.									
					70,000	80,000			15 in 8 in.	180° 0 = 2 1/2 x t.	Specimens 1/4 in. x 1 in. cut from finished axle.							Axle to be turned over after each blow.	
.07	.04									Piece 14 in. long to be sent to R. R. laboratory from which drillings will be taken for analysis with 5/16 in. diam. drill on radial line 40% of distance out from centre to circumference of axle.		1,610	43	3	5	7	8	Drop machine same as M. C. B. Axle to be turned over after 1st and 3d blows.	



SYNOPSIS OF SPECIFICATIONS FOR RAILROAD AXLES.

COMPILED FOR COMMITTEE NO. 1, AMERICAN SECTION OF THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

Physical properties.						Drop test.								Remarks.			
Ultimate strength per sq. inch.		Elastic limit.	Elongation, per cent.		Bending.	Test piece.	Diameter at center, inches.	Weight of drop, pounds.	Height of drop, feet.	Distance between supports, feet.	Number of blows.	Desired deflection, inches.	Maximum deflection, inches.				
Not less than.	Not more than.		Desired.	Not less than.													
None required.						Test piece 6 in. long cut from test axle. Borings for analysis will be taken by 5/16 in. drill acting parallel to axis of axle at a point on radial line, 40% of distance from center to circumference.	4 7/8	1,610	23 1/2	3	5	7 1/2	8 3/4	Drop machine to have spring base as described in specifications. Axles must be turned over after first and third, and when required after fifth blow.	Must conform to limiting print.		
							4 3/4	1,640	31	3	5	7	8				
							4 3/4	1,610	34	3	5	7	8				
							4 3/4	1,610	34	3	5	6	7				
							5 1/8	1,610	43	3	5	4 1/2	5 1/2				
							4 3/4	1,610	25 1/2	3	5	5 1/2	6 1/2				
							5	1,640	38 1/2	3	5	5	5 1/2				
							5 1/4	1,640	43	3	5	4 1/2	5 1/2				
							5 1/2	1,610	43	3	7	4	4 1/2				
								Ditto.	4 5/8	1,640	31	3	5			7	8
					5 1/8	1,640	43		3	5	6	7					
					5 1/4	1,640	43		3	7	4 1/2	5 1/2					
							4 3/4	1,640	23	3	5			Firm supports. Axle to be turned over after each blow. For axles over 4 1/4 in. diameter, at center add 2 ft. to height of drop for each 1/4 in. increase at center.	To conform to print.		
							4 3/4	1,610	23	3	5			Axle to be turned over after each blow. Increase height of drop 1 ft. for each 1/4 in. in diameter of axles over 4 1/4 in. at center.	Conform to specifications.		
						Borings to be taken from one end of axle half way between center and circumference.	4 1/4	1,610	26	3	5		7	Drop machine same as M. C. B.	Conform to specifications.		
					4 5/8		1,640	32	3	5		7					
					5 1/8		1,640	43	3	5		7					
						Test piece 6 in. long cut from test axle. Borings for analysis will be taken by 5/16 in. diameter drill acting parallel to axis of axle at a point on radial line 40% of distance from center to circumference.	4 5/8	1,610	34	3	5	7	8	Drop machine same as M. C. B.	Must be turned over after each blow. Mensie Co. M. or exc.		
					5 1/8		1,640	43	3	5	6	7					
								1,640	25	3	5			Turn axle over after each blow.	Leave axle to allow.		
								1,640	27	3	6			Ditto.			
						Drillings for analysis to be taken half way between center and edge with 5/16 in. diameter drill.		1,64	40	3	5	7	8	Ditto.			
75,000								1,650	20	3	6			Axle to be turned after 1st, 3d and 5th blows.	To be turned over after each blow.		
								1,650	28	3	6						
								1,640	25	3	5			To be turned over after each blow.	To agree to.		
						Journals		1,610	15	3	3		6 after first blow.	Rigid supports. Axle to be turned over after each blow. Axle to receive 8 blows.			
								1,640	25	3	5						
							4 1/4	1,640	28	3	5						
							4 1/4	1,640	28	3	5						
							3 3/4	1,640	20	3	5						
							3 3/4	1,610	25	3	5						
							4	1,610	28	3	5						
							4 1/4	1,640	25	3	5						
							4	1,640	18	3	5						
							4 1/4	1,610	20	3	5						
							4 1/4	1,610	28	3	6						
							5	1,640	40	3	6						
							5 1/4	1,640	40	3	8						
	54,000	64,000	32,000		22 in 8 in.	For chemical analysis piece of axle will be cut at a distance of 14 in. from end, and a circle inscribed on face of section thus made, having for radius 40% of radius of section. Borings will be taken with 5/16 in. drill acting parallel to axis of axle and starting on 40% circle.	4 1/4	1,640	28 1/2	3	6	7	8	Drop machine same as M. C. B. Axle to be turned over after 1st, 3d and 5th blows. If test axle fails two more must stand test to accept heat.	Axle must be turned over after each blow.		
							4 5/8	1,610	34	3	6	7	8				
							5 1/8	1,640	43	3	5	6	7				
							5 1/4	1,640	43	3	7	4 1/2	5 1/2				
							4 1/4	1,640	25	3	5		8 after any blow.	Drop machine same as M. C. B. Axle to be turned after each blow.	Rough vary rough not to		
60	70,000			20 in 2 in.	15	Two test pieces cut from test axle, the centre lines of which shall be 1 in. from centre line of axle.	4	1,640	20	3	5			Axles to be turned over after 1st and 3d blows. For excess in diam. of axles add 2 ft. to height of drop for each 1/4 in. increase in diam. at centre. If drop machine is of spring base pattern add 2 ft. to heights given in table.	Conform to specifications.		
							4 1/4	1,640	23	3	5						
							4 3/4	1,640	24	3	5						
							4 5/8	1,610	26	3	5						
							4 5/8	1,640	28	3	5						
							4 1/4	1,640	30	3	5						
							4 1/4	1,640	25	3	10			Axles to be turned over after each blow.	Conform to specifications.		
							4 5/8	1,640	28	3	10						
							4 5/8	1,640	29	3	5			Axle to be turned over after each blow.	Conform to specifications.		
						Drillings for analysis to be taken from end of test axle 2 of distance outward from centre to circumference.	4 5/8	1,610	31	3	5		8 1/4	Test given is for spring base. If solid base 2 ft. will be allowed from height of drop.	Conform to drawing.		
						Drop test same as B. & O. R. R.											
	70,000	80,000		15 in 8 in.	180° 6 = 2 1/2 x t.	Specimens 1/4 in. x 1 in. cut from finished axle.		1,640	25	3	5			Axle to be turned over after each blow.			
						Piece 14 in. long to be sent to R. R. laboratory from which drillings will be taken for analysis with 5/16 in. diam. drill on radial line 40% of distance out from centre to circumference of axle.		1,610	43	3	5	7	8	Drop machine same as M. C. B. Axle to be turned over after 1st and 3d blows.	Axles to be turned over after each blow.		

Dimensions.	Brands.	Centering.	Finish.	Inspection.
Must conform in sizes, shapes and limiting weights given on order and print sent with it.	Before being offered for test axles must be legibly stamped on portion "A" with heat number followed at a distance of 2 in. with last two figures of year and on cylindrical central portion with maker's name.	60° centers with clearance given at point to avoid dulling the shop lathe centers	To be finished in a workmanlike manner, free from cracks, seams or flaws that can be detected by the eye. All rough turned except portion marked "A" on diagram.	Not less than 30 axles from a heat considered; each heat in separate pile, from which one will be selected at random by inspector to be tested under drop. Must meet chemical and physical tests. Inspected at mill notify Supt. M. P.
	Must be legibly stamped when offered for test on portion "A" with heat number and date and on cylindrical portion at center with maker's name.	Ditto.	Ditto.	Ditto.
To conform to dimensions on blue print.	Stamp "steel" and maker's name near center, also heat number.	60° centers.....	Finish in workmanlike manner, free from cracks and unwelded seams. Forged journals. Rough turned on journals and wheel seats only.	Axles to be inspected at destination. As many as possible from a heat; never less than 20. Test axle from each heat.
Conform to dimensions shown in specifications.	Stamp "steel" on one end; also stamp maker's name or initials, heat number and mark of hammer man.	60° centers .....	Free from cracks and unwelded seams. Cut to exact length.	As many as possible from a melt. Pile each melt separately. One test axle will be selected from each pile by inspector. Optional with engineer whether axles will be tested at mill or destination.
Conform to drawings with specifications.	Stamp near middle with $\frac{3}{4}$ in. letters "steel," name of maker date (month and year) and heat number.	75° centers, $\frac{3}{4}$ in. deep	Rough turned on journals and wheel seats with flat nosed tool. Cut to exact length.	One test axle from each heat selected at random.
Must be made to M. C. B. standards and must conform to sizes and dimensions on print furnished by R. R. Co. Must not fall below dimensions or exceed them by more than $\frac{1}{8}$ in.	Stamp near center "steel," maker's name or initials, number of heat and make of steel.	60° centers drilled $\frac{1}{4}$ in. deeper than point of angle.	Finish in workmanlike manner, free from cracks, seams or flaws that can be detected by the eye. Must finish in lathe with journals absolutely free from flaws. Rough turned with flat-nosed tool.	Not less than 30 axles from a heat considered. Each heat to be piled separately. One axle from each heat to be selected by inspector for test.
Leave all parts marked $\frac{1}{4}$ in. larger to allow for finishing.	Stamp "Freight," maker's name, date and nature of material. Stamp maker's name, date, nature of material and "Passenger"; stamping not to be nearer than 2 in. nor farther than 10 in. from wheel seat.	Accurately centered.	Free from all visible defects, rough turned journals	One test axle from each 100.
Ditto.		60° centers not less than $\frac{1}{4}$ in. deep and drilled for clearance for turning.	Ditto.	One test axle to be supplied for each 50; test axle will be selected at random from consignment. Orders of 50 or less must be from one heat; 50 to 100 not more than two heats.
Ditto.	Stamp maker's name, date and process of manufacture.	All to be well centered.	Square, well finished ends to be round, clean and smooth, without seams or flaws. Tender to have journals swaged.	One test axle to be furnished for each 50, but any batch irrespective of number may be tested.
To be forged accurately to drawing	To be stamped cold, with maker's initials midway between center and inside edge of wheel fit.	Accurately and deeply centered, 60° centers.	Workmanlike manner. Journals, dust guards and wheel fits rough turned.	One test axle to be furnished from each 100 to be selected at random.
To agree exactly with drawing.....			Rough turned throughout, free from cracks, unwelded seams and other flaws.	One test axle to be furnished for each 50.
Ditto.				
Must conform in shape and size to dimensions on drawing, must not fall below dimensions or exceed them by more than $\frac{1}{8}$ in.	Plainly and deeply stamped at point designated by drawing, with maker's name or initials, day, month and year, heat no. and word "steel."	60° centers .....	Cut off and faced to exact length. Well hammered. Must finish in lathe absolutely free from flaws of any kind.	One axle to be selected at random from each heat. Will be inspected at mill.
Axle must agree exactly with drawing 779.	To be stamped with heat number and initials of maker midway between center and inside edge of wheel fit.	Accurately and deeply centered, 60° centers.	Ends must be squared up.	One test axle from each heat. Inspected at mill, notify Supt. M. P.
Rough sized dimensions must not vary more than $\frac{1}{16}$ in. on portion rough turned or $\frac{1}{8}$ in. on portion not turned.	Legibly stamped near centre with letters and figures $\frac{3}{4}$ in. high, name of maker, date, heat number and word "steel."	60° centres, $\frac{1}{2}$ in. deep.	No defective workmanship, cracks or unwelded seams. Passenger axles rough turned throughout. Freight axles rough turned on journals and wheel fit all forged journals.	Not less than 30 axles from a heat. One test axle from each heat. Notify purchasing agent six days before 100 or more are ready for inspection.
Conform to dimensions given.	Stamp maker's name, heat number and date; also "steel" in $\frac{1}{2}$ in. letters.	60° centres. See diagram in specifications.	Free from cracks, slivers, seams and flaws of any kind. Journals swaged.	At least 25 axles from a heat, each heat to be piled separately. One test axle from each heat, and every 100 of a heat to be selected at random.
Conform to shape and sizes on print with order.	Stamp maker's name and heat number.	60° centers.	Journals and wheel seats rough turned with flat-nosed tool.	To be tested at mill, notify Supt. M. P. As many axles from a heat as possible. Axles from same heat to be piled together. One test axle from each heat; if desired a piece of tested axle to be supplied for etching test.
Conform to prints as ordered.	Stamp "steel" in $\frac{1}{2}$ in. letters also maker's name on body of axle. Passenger axles to be stamped on one end with "P" $\frac{3}{4}$ in. high.	60° centres.	Ends faced. All journals swaged. Freight axles rough turned on journals and wheel fit. Passenger axles rough turned throughout. Free from all defects.	One test axle to be supplied for each 100 selected at random at mill or destination.
Conform closely to dimensions on drawing.	Stamp near centre "steel," heat number and maker's name.	60° centres.	Cut accurately to length, ends faced. Journals and wheel seats rough turned. Free from seams and other defects.	One test axle from each heat will be inspected at mill. Notify Supt. of tests two days before ready for test
M. C. B. standard.			Finished in workmanlike manner, free from imperfections that would impair their efficiency.	One test axle for each 100. If first fails two more must stand test to pass lot.
Axles to conform to sizes, shapes and limiting weights on print with order.	Stamp in centre, name of maker and heat number.	60° centers.	Free from cracks, seams or flaws that can be detected by the eye.	Same as P. R. R. Co.

COMPILED FOR COMMITTEE NO. 1.—AMERICAN SECTION, INTERNATIONAL

Names.	Kind of Steel	Test piece for analysis.	Kind of forging.	Chemical composition. "D" denotes desired, "B" below and "A" above.													
				Carbon.			Manganese.			Silicon.			Phosphorus.			Sulfur.	
				D.	Not B.	Not A.	D.	Not B.	Not A.	D.	Not B.	Not A.	D.	Not B.	Not A.	D.	Not B.
Erie Railroad, Feb. 1, 1899.....	O. H.	.....	Miscellaneous.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.05	.....
L. S. & M. S. Ry .....	O. H.	.....	Piston rods.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.05	.....
Lehigh Valley R., M. P. 11, Sept. 16, '95.	O. H.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.06	.....
N. Y. C. & H. R. R. R., Oct., 1899.....	O. H.	.....	.....	.....	.27	.40	.....	.60	.....	.....	.....	.....	.....	.....	.....	.04	.....
Pennsylvania R. R. Co., 5a, Dec. 1, 1893.	O. H.	See test column.	Driving axles.	.40	.35	.50	.50	.....	.60	.20	.....	.15	.03	.....	.05	.03	.....
Pennsylvania R. R. Co., 6, Nov. 8, 1897..	O. H.	{ Same as for driving axles. }	Crank pins.	.45	.....	.....	.60	.....	.....	.05	.....	.....	.03	.....	.05	.04	.....
B. & O. Ry , 4tb, Sept. 1, 1898 .....	O. H.	.....	Crank pins.	.....	.40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.04	.....
B. & O. Ry., 3a, Feb. 1, 1897 .....	O. H.	{ Check analysis from test piece. }	Driving axles.	.....	.35	.....	.....	.....	.60	.....	.....	.....	.....	.....	.....	.06	.....
B. & O. Ry , 49a, Aug. 1, 1896 ..	O. H.	{ Check analysis from test piece. }	Main and parallel rods. }	.....	.....	.....	.....	.....	.60	.....	.....	.....	.....	.....	.....	.05	.....
Chicago & Northwestern R., Apr. 1, '98.	O. H.	.....	Parallel rods.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Missouri, Kansas & Texas, Feb. 2, 1900.	O. H.	.....	Miscellaneous,	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.05	.....
Southern Ry., Feb 1, 1896 .....	{	.....	Piston rods.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Southern Ry., May 9, 1896.....		.....	Parallel rods.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Southern Ry., May 9, 1896.....		.....	Crank pins.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.05
Southern Ry., May 9, 1896. ....	{	.....	Driving axle.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.07	.....
		O. H.	See test piece.	{ Locomotive and tender axles. }	.....	.....	.....	.....	.....	.70	.....	.....	.....	.....	.....	.....	.07
C., B. & Q. R. R. Co., Feb 20, 1897. ....	O. H.	.....	{ Side and piston rods. }	.....	.25	.40	.....	.....	.65	.....	.....	.....	.....	.....	.....	.05	.....
C., B. & Q. R. R. Co .....	O. H.	.....	Crank pins.	.....	.30	.45	.....	.....	.65	.....	.....	.....	.....	.....	.....	.05	.....
C., B. & Q. R. R. Co .....		See test piece.	{ Driving and engine truck axles. }	.....	.35	.50	.....	.....	.60	.....	.....	.05	.....	.....	.....	.05	.....
N. & W. R. R. Co., 7a, Jan 1, 1891.....	.....	.....	Crank pins.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
N. & W. R. R. Co., 8b, Apr. 25, 1894.	.....	.....	Rods and guides.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.05	.....
B. L. W., June 1, 1897 .....	O. H.	See test piece.	{ Axles, pins, rods, guides and similar forgings }	.40	.....	.....	.....	.....	.60	.....	.....	.....	.....	.....	.....	.05	.....
Pennsylvania R. R. Co .....	.....	.....	{ Main and parallel rods. }	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....



and "A" above.			Physical properties.						Test piece.	Remarks.
Sulphur.			Ultimate strength. Lbs. per sq. in.			Elongation, Per cent.				
D.	Not B.	Not A.								
5	.....	.05	85,000	80,000	90,000	20 in 2 in.	17 in 2 in.	{ Each test specimen to be machined cold, longitudinally taken from a prolonged portion of forging midway between centre axis and surface. Size, 2 in. $\times$ $\frac{3}{8}$ in. diam.	Not less than 25% by weight to be discarded from top end as cast of each ingot. Defective forging will be returned at manufacturer's expense.	
5	.....	.05	.....	60,000	70,000	.....	22 in 8 in.	{ Longitudinal specimen 2 in. long $\times$ $\frac{1}{2}$ in. diam., machined cold half way between central axis and outside; from full-sized prolongation. See remarks.	25% discard from top of ingot. Test piece must be cut from upper end of upper bloom in ingot.	
6	.....	.06	85,000	80,000	.....	20 in 2 in.	17 in 2 in.	{ Drillings will be taken with $\frac{5}{16}$ in. drill 40% of distance out from centre of axle; from crop end each melt.		
4	.....	.04	80,000	75,000	85,000	.....	20 in 2 in.	{ Two from one pin selected from each lot of 50, centre line of test must not be nearer than 1 in. to centre line of pin.	Variation between two tests of same pin must not exceed 5,000 T. S. or 5% elongation.	
5	.03	.....	.....	See remarks	80,000	95,000	18 in 8 in.	{ Two tests $\frac{1}{2}$ in. diam. $\times$ $2\frac{1}{2}$ in. between shoulders cut from pin of each heat, cut midway between centre and edge.	As many pins as possible to be made from a heat.	
5	.04	.....	85,000	80,000	.....	.....	12 in 8 in.	{ Two tests $\frac{1}{2}$ in. diam. $\times$ $2\frac{1}{2}$ in. between shoulder to be cut from extra length of axle, from each heat. Centre line of test to be midway between centre and edge. The extra length to be nearly cut off so that it can be broken off at destination.	As many axles as possible to be made from a heat. To be rough turned throughout 60° centres cut to exact length.	
6	.....	.04	90,000	85,000	.....	15 in 2 in.	{ 15 in 2 in. if T. S. is above 90,000 lbs. 12%.	{ Same as above.	{ As many rods as possible to be made from a heat.	
6	.....	.04	E. L. 40,000	80,000	.....	.....	18 in 2 in.	{ One end of each bloom must be drawn to a test piece 2 in. square $\times$ 18 in. long. To remain attached until bloom is inspected.		
5	.....	.04	.....	70,000	80,000	.....	20 in 2 in.	{ Test piece cut from forging 4 in. in diam. hammered from bloom and allowed to cool.		
5	.....	.....	85,000	60,000	.....	20 in 2 in.	15 in 2 in.	{ One rod from each heat must be 6 in. extra long and from this two test pieces will be cut.		
5	.....	.....	.....	70,000	80,000	.....	20 in 2 in.	{ Same as above.	{ Rods must be taken from as few heats as possible.	
5	.....	.....	.....	75,000	.....	.....	18 in 8 in.	{ One pin from each heat will have two test pieces cut from it.	As many pins from each heat as possible.	
5	.....	.....	.....	80,000	.....	.....	15 in 2 in.	{ One axle from each heat will be made 6 in. extra long and from this two test pieces will be cut.	As many axles as possible from each heat.	
7	.....	.....	.....	80,000	.....	.....	18 in 8 in.	{ Drillings to be taken from end of each test axle in presence of inspector. Analysis to be made by Southern Ry. Co.'s chemist.	As many axles as possible from each heat, preferably 50 or more, never less than 30.	
7	.....	.....	.....	.....	.....	.....	.....	{ One end of each billet to be drawn down by manufacturer to a test bar $\frac{1}{2}$ in. square and 10 in. long. To remain attached to billet.		
5	.....	.05	.....	70,000	80,000	.....	22 in 4 in.	{ Same as above.		
5	.....	.05	.....	75,000	85,000	.....	20 in 4 in.	{ Borings will be taken from end of axle, half way between centre and circumference.	All axles must be annealed after forging. Etching test must show homogeneous material free from elongated blow holes or lap overs.	
5	.....	.04	.....	75,000	85,000	.....	20 in 4 in.	{ One pin from every 51 to have two test pieces cut out.		
5	.....	.....	85,000	80,000	.....	15 in 2 in.	12 in 2 in.	{ One billet from each shipment will have a piece drawn from it under the hammer about 2 in. square by 12 in. long.		
5	.....	.....	.....	80,000	.....	.....	15 in 2 in.	{ Test piece to be machined cold from a full size bloom from each heat. Drillings must be taken from a point midway between centre and surface of bloom.		
5	.....	.05	80,000	75,000	90,000	20 in 2 in.	15 in 2 in.	{ One billet from each 25 to be drawn down under hammer and turned to $\frac{1}{2}$ in. diam. 2 in. long.		
5	.....	.....	85,000	80,000	.....	15 in 2 in.	12 in 2 in.			



8. For driving axles one longitudinal test specimen shall be cut from one axle of each melt. The center of this test specimen shall be half way between the center and outside of the axle.

Number and  
Location of Ten-  
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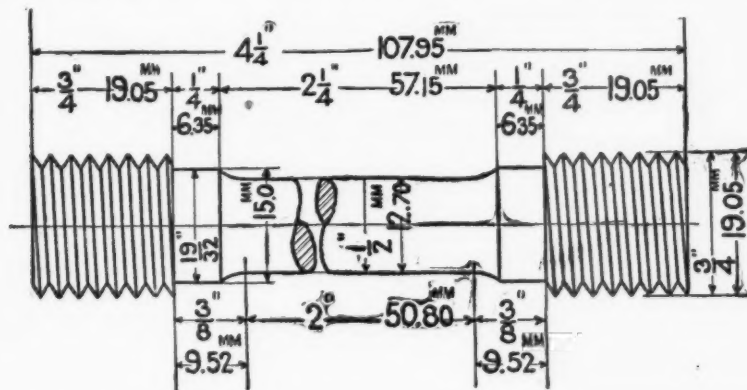
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6. Carbon steel and nickel steel driving wheel axles shall not be subject to the above drop test.

#### TEST PIECES AND METHODS OF TESTING.

7. The standard turned test specimen one-half inch ( $1/2''$ ) diameter and two inch ( $2''$ ) gauged length, shall be used to determine the physical properties specified in paragraph No. 4. It is shown in the following sketch :



8. One longitudinal test specimen shall be cut from one axle of each melt. The center of this test specimen shall be half way between the center and outside of the axle.

Number and  
Location of Ten-  
sile Specimens.

9. The points of supports on which the axle rests during tests must be three feet apart from center to center; the tup must weigh 1,640 pounds; the anvil, which is supported on springs, must weigh 17,500 pounds; it must be free to move in a vertical direction; the springs upon which it rests must be twelve in number, of the kind described on drawing; and the radius of supports and of the striking face on the tup in the direction of the axis of the axle must be five (5) inches. When an axle is tested it must be so placed in the machine that the tup will strike it midway between the ends, and it must be turned over after the first and third blows, and when required, after the fifth blow. To measure the deflection after the first blow prepare a straight edge as long as the axle, by reinforcing it on one side,

Drop Test  
Described.

equally at each end, so that when it is laid on the axle, the reinforced parts will rest on the collars or ends of the axle, and the balance of the straight edge not touch the axle at any place. Next place the axle in position for test, lay the straight edge on it, and measure the distance from the straight edge to the axle at the middle point of the latter. Then after the first blow, place the straight edge on the now bent axle in the same manner as before, and measure the distance from it to that side of the axle next to the straight edge at the point farthest away from the latter. The difference between the two measurements is the deflection.

10. The yield point specified in paragraph No. 4 shall be determined by the careful observation of the drop of the beam, or halt in the gauge of the testing machine.

**Yield  
Point.**

11. Turnings from the tensile test specimen of driving axles, or drillings taken midway between the center and outside of car, engine, and tender truck axles, or drillings from the small test ingot if preferred by the inspector, shall be used to determine whether the melt is within the limits of chemical composition specified in paragraph No. 2.

**Sample for  
Chemical  
Analysis.**

#### FINISH.

12. Axles shall conform in sizes, shapes and limiting weights to the requirements given on the order or print sent with it. They shall be made and finished in a workmanlike manner, and shall be free from all injurious cracks, seams or flaws. In centering, sixty (60) degree centers must be used, with clearance given at the point to avoid dulling the shop lathe centers.

#### BRANDING.

13. Each axle shall be legibly stamped with the melt number and initials of the maker at the places marked on the print or indicated by the inspector.

#### INSPECTION.

14. The inspector representing the purchaser, shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture, prior to shipment.



equally at each end, so that when it is laid on the axle, the reinforced parts will rest on the collars or ends of the axle, and the balance of the straight edge not touch the axle at any place. Next place the axle in position for test, lay the straight edge on it, and measure the distance from the straight edge to the axle at the middle point of the latter. Then after the first blow, place the straight edge on the now bent axle in the same manner as before, and measure the distance from it to that side of the axle next to the straight edge at the point farthest away from the latter. The difference between the two measurements is the deflection. The report of the drop test shall state the atmospheric temperature at the time the tests were made.